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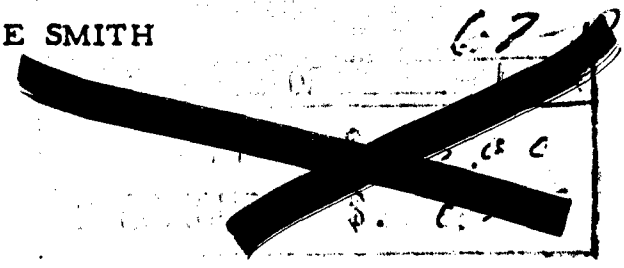
REPORT R-1755

USER REQUIREMENTS FOR CHEMICAL INFORMATION AND DATA SYSTEM (CIDS)

by

CHARLOTTE SMITH



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April 1965

UNITED STATES ARMY
FRANKFORD ARSENAL
RESEARCH & DEVELOPMENT
DIRECTORATE

PHILADELPHIA, PA. 19137

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ABSTRACT

Eighty-two users of chemical information from seventeen Army installations were surveyed to determine their information requirements. Their present methods for conducting retrospective bibliographic searches and searches for specific facts and data were explored. Tools and techniques used to maintain current awareness were recorded, and information services were discussed. Preferred formats and desired response times for requests for references and chemical data, tolerance for "noise" and overlooked relevant material, and traffic were determined. An analysis of 308 examples of questions asked by users of chemical information is included. This survey was conducted as one phase of the work involved in the design of an Army Chemical Information and Data System (CIDS).

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INTRODUCTION

Several installations within the Department of the Army are collaborating in the design of the Army Chemical Information & Data System (CIDS), a project within the Army Scientific and Technical Information (STINFO) program coordinated by the Director of Army Technical Information. Since its establishment, heavy emphasis has been placed on the need for CIDS to be a user-oriented system, and that user needs be defined as a prerequisite to system design. As a part of Frankford Arsenal's project responsibility, the requirements of chemists and related scientists and engineers for chemical information were surveyed.

Bourne[1] makes a distinction between user requirements (those related mainly to the over-the-counter services of direct interest to the user) and system management requirements (those concerned with the behind-the-scenes activities of the information system). He contends that while the user is justified in expressing needs about the former, he has no right to do so with respect to the latter. As a limitation of this survey, the user needs explored are restricted to Bourne's definition.

No statistical evaluation can be made in this report.

BACKGROUND

The large numbers of user and use studies conducted in the past have been reviewed by Tornudd[7], Menzel[3], and Jahoda.[4] In a thoughtful article on information needs of current scientific research, Menzel[5] describes three needs which any science information system must strive to satisfy: 1) a current awareness function, 2) a reference function, i.e., providing up-to-date answers to specific questions, and 3) an exhaustive search function. The present study is in part an attempt to determine how users of chemical information fulfill these functions now, and represents the minimum requirements for an information system, a base level from which designers can build.

See REFERENCES

THE INTERVIEW

Due to the depth of the material sought, the interview was chosen as the best method for collecting the data. A preliminary interview guide was developed and tested on six engineers and chemists at Frankford Arsenal. Modifications and improvements were made to bring the guide to its final form, a copy of which appears as Appendix A. The guide itself was used as an aid to the interviewer; the user never actually read any part of it. Space was provided on the guide for recording responses.

Questions generally were open-ended, designed to encourage the interviewee to talk freely while the interviewer recorded the desired information. Only 2 multiple choice questions were included. All interviews were conducted by one interviewer from June through October, 1964; they varied in length from one to three hours, with an average time of 1.8 hours.

The interview was divided into several sections. After an introduction which gave briefly the purpose of the interview, a section was devoted to recording statistics about the interviewee (education, job title, grade level, experience and mission).

When the subject of a major background type retrospective search was introduced, the user was asked to describe a particular search he had made recently. We were primarily interested in the subject of the search, whether or not he made the search himself, the actual step-wise procedures he employed in finding the information, did he get the information, did he get it in time for it to be useful, and how long it took. He was asked to identify any problems encountered in getting the information, offer possible solutions or other improvements. Discussion was directed next to instances when he was looking for a specific fact or data; the same kind of information was revealed about searches of this kind. The subject of current awareness was raised; information was recorded about journals scanned regularly, society memberships, attendance at meetings and use of alerting devices. He was then asked some details about personal reference files and any other specialized or reference data files available to him. These questions were asked to uncover any specialized holdings which might be considered as potential input to a larger system. We were interested in the subject matter, size, nature (i.e., references to whole documents, documents themselves, or highly specialized data files) and form of indexing, if any. A separate report will summarize the responses to these questions.

All of the interview to this point has been concerned with the interviewee, his own habit patterns and the information tools accessible to him. In order to orient him within the framework of an information system, he was shown a card listing services which could be provided by an information system. This list was not comprehensive, but rather illustrative of the kinds of services which could be provided. He was asked to indicate which would be of interest to him, and to describe any other services which would be valuable.

The final section of the interview was devoted to gathering information immediately useful to the CIDS. The interviewee was given a brief summary of the chemical compound structure file with its potential for full structure and sub-structure search, and told that CIDS hopes to provide two kinds of service, i.e., one which supplies references to work which has been done and the other which supplies actual facts or data. Two questions were devised to determine the user's preference of format in answer to a request for references on a specific subject and acceptable response time for this kind of request. Two other questions were asked to establish the preferred format in answer to a request for data related to one or more chemical compounds and acceptable response time for this kind of request. One question sought information about the "noise" tolerance, i.e., the amount of irrelevant material which the user would be willing to accept in response to a request for references. Another question asked the amount of relevant material he feels we must be able to provide. The users opinion was polled as to whether or not unpublished data and information should be included, and he was asked to estimate the frequency of his requests (to give us an approximation of how much traffic we can expect). Finally, he was asked to give several examples of questions he might ask the CIDS system. It was believed that a composite list of questions would be a helpful tool to the designers of the system.

THE SAMPLE

Twenty-three organizations at seventeen installations within The Army Materiel Command (AMC) and The Surgeon General had indicated willingness to cooperate in the CIDS program. These organizations were requested, through command channels to provide as candidates for interview the names and descriptive job titles of users of chemical information.

It was suggested that users be chosen from basic and applied researchers and engineers in the various fields of chemistry, also related fields such as toxicology, pharmacology and metallurgy. Additional criteria required that they should fall within the GS-11 and GS-15 range, and be actively engaged in a technical rather than an administrative capacity. The actual nomination of interview candidates was made by a knowledgeable individual within each participating organization.

Twice as many names were requested as required. In all cases the candidate names were screened against the list of interviewees selected by the Auerbach Corporation (who were surveying scientists and technologists for a somewhat similar DOD study) to avoid interviewing the same person twice.

Table I presents the distribution of the population by organization. The sample broken down by descriptive job title, is indicated in Table II. The final selection of interviewees was made at Frankford Arsenal, based on job title, lack of supervisory function, and availability for interview on the scheduled visit date. The total number of scientists interviewed was 82.

Since descriptive job titles are not really informative of the kind of work done, the positions held by the interviewees were categorized into the scientific and technical areas defined by the DOD "Hitch Method".[6] The distribution is given in Table III. In this way it becomes obvious that the sample is somewhat unbalanced with a heavy emphasis in the areas of basic and applied research.

Table IV shows the grade range of the population. The grade figures have been adjusted to include on the GS scale four users who were in the military and one private company employee working within the grounds of a government installation. In these cases, an evaluation was made of the grade they probably would have had if they fell under the GS scale. The educational achievements of the interviewees are tabulated in Table V.

The small size of the sample and the diversity of the job titles does not permit a rigorous statistical evaluation of the data. Rather, a narrative summary of some of the more interesting findings is presented.

Table I. DISTRIBUTION OF INTERVIEWEES BY ORGANIZATION

Organization	Location	Users
U. S. Army Electronics Laboratories	Ft. Monmouth, N. J.	4
Feltman Researc Laboratories	Picatinny Arsenal, Dover, N. J.	5
PLASTEC	Picatinny Arsenal, Dover, N. J.	1
Chemical Research & Development Labs	Edgewood Arsenal, Md.	11
Biological Laboratories	Ft. Detrick, Frederick, Md.	3
Dugway Proving Ground	Dugway, Utah	4
Deseret Test Center	Ft. Douglas, Salt Lake City, Utah	2
Ballistics Research Laboratories	Aberdeen Proving Ground, Md.	3
Coating & Chemicals Laboratories	Aberdeen Proving Ground, Md.	3
Limited War Laboratory	Aberdeen Proving Ground, Md.	2
Natick Laboratories	Natick, Mass.	4
Army Materials Research Agency	Watertown Arsenal, Watertown, Mass.	3
Springfield Armory, R&E Div.	Springfield, Mass.	3
Benet Research & Engineering Labs.	Watervliet Arsenal, Watervliet, N. Y.	3
Propulsion Laboratory	Redstone Arsenal, Huntsville, Ala.	3
Rohm & Haas Co.	Redstone Arsenal, Huntsville, Ala.	1
Physical Science Laboratory	Redstone Arsenal, Huntsville, Ala.	2
Walter Reed Army Institute for Research	Walter Reed Army Hospital, Washington, D.C.	4
Armed Forces Institute for Pathology	Walter Reed Army Hospital, Washington, D.C.	1
Engineer Research & Development Labs.	Ft. Belvoir, Va.	3
Army Tank Automotive Center	Detroit Arsenal, Warren, Mich.	4
Rock Island Arsenal Laboratory	Rock Island, Ill.	6
Pitman-Dunn Institute for Research	Frankford Arsenal, Phila., Pa.	7
	TOTAL	82

Table II. DISTRIBUTION OF INTERVIEWEES BY JOB DESCRIPTION

Descriptive Job Title	No. Interviewed	%
Physical Chemist	19	23.3
Organic Chemist	17	20.8
General Chemist	9	10.3
Analytical Chemist	8	9.9
Chemical Engineer	8	9.9
Biochemist	6	7.4
Materials Engineer	4	5.0
Radiation Chemist	2	2.5
Metallurgist	2	2.5
Mechanical Engineer	1	1.2
Solid State Physicist	1	1.2
Biologist	1	1.2
Zoologist	1	1.2
Food Technologist	1	1.2
Bacteriologist	1	1.2
Pharmacologist	1	1.2

Table III. DISTRIBUTION OF INTERVIEWEES BY SCIENTIFIC AND TECHNICAL AREA

Area	No.
Basic Research	24
Exploratory Development (Applied Research)	37
Advanced Development	3
Engineering Development	--
Operational Systems Development	1
Reliability - Quality Control	1
R & D Support	16

Table IV. DISTRIBUTION OF INTERVIEWEES BY GRADE

Grade	No.
GS-11	4
GS-12	16
GS-13	32
GS-14	21
GS-15	8
PL-313	1

Table V. DISTRIBUTION OF INTERVIEWEES BY EDUCATION

Educational Achievement	No.
B.S. (or equivalent)	31
M.S. (or equivalent)	14
Ph.D. (or equivalent)	37

THE RETROSPECTIVE BACKGROUND SEARCH (Questions 1-12)

Of the eighty-two people interviewed, sixty-nine performed their own searches. Eight asked others (librarians, subordinates, or contractors) to perform the searches; three performed their own searches with the help of others; and one (a technical-administrative type) had no occasion to make retrospective searches at all.

The subjects of the searches, categorized in Table VI, were extremely varied not only in the field covered, but also breadth of coverage.

Table VI. SUBJECTS OF RETROSPECTIVE BACKGROUND SEARCHES

Subject of Search	Percent
Related to classes of compounds	35
Related to one compound or element	20
Analytical Methods	10
Process information	10
Characteristics of materials	8
Applications for a particular purpose	5
Others	12

The "Others" were broad searches, e.g., foundry technology advances in last three years, photosynthesis in plants, and periodic electron phenomena. Many searches were performed to uncover every article which had ever been written about the subject; many others, however, were interested in uncovering only enough information to give the guidance required.

It is not difficult then to understand why there was such a large time variation in completing these searches. The reported completion times for personally conducted searches are shown in Table VII. Not all of these searches were continuous; the figures then do not represent man - days, man-months or man-years of effort spent to get information, but they do indicate that most of the users were not working against any deadlines. In fact, only two searches discussed had any imposed deadline. In all cases, the users claimed to have gotten the information in time for it to be useful.

The methodology used for searching was summarized by counting the number of times a particular tool or technique was mentioned. Most chemist users cited Chemical Abstracts wherein much more use was made of the subject index (50) than formula index (13) or author index (8).

Other specialized abstracts like Corrosion Abstracts, A.S.M. Abstracts, Chromatography Abstracts, Biological Abstracts, Analytical Abstracts were mentioned a total of 16 times. Texts and references in applicable areas were used by 23, Chemische Zentrallblatt by 2, Beilstein by 9, and Angewandte Chemie by 1. Personal reference files were mentioned 8 times.

Table VII. COMPLETION TIMES FOR RETROSPECTIVE SEARCHES PERFORMED PERSONALLY BY INTERVIEWEE

Time	No. of Searches
Less than one day	13
One - three days	11
Three days - one week	11
One - two weeks	4
Two - three weeks	4
One month	5
Two months	5
Three months	1
Six months	6
Seven months	1
One year	2
Two years	1
Did not know	5
TOTAL	69

Review journals were cited 6 times, appropriate individual journals, 8 times. Ten users requested DDC searches. Thirty-six people mentioned the value of personal contact with experts and colleagues, some at the start of the search for possible leads to work in a field and some at the latter stages for details on work published and knowledge of current or very recent work, not yet published.

Specialized information centers, i.e., C.P.I.A., Radiation Effects, Prevention of Deterioration, Defense Metals and PLASTEC were contacted a total of ten times. Searches through TAB[7] and Nuclear Science Abstracts[2] were mentioned nine times; searches through local card indexes of government and contractor reports were made 15 times. In only four cases was a librarian asked to do any searching.

What is little-used is also of interest. Only one person used an NRC Referral Service, which provides information on who is doing work in a specific area; no one used the Science Information Exchange; only one of

the 17 organic chemists interviewed used Index Chemicus for retrospective searching; only one interviewee used Science Citation Index for forward searching, although 36 used citations in appropriate journal articles for backward searches.

A good deal of probing was done concerning the manner in which abstracts were used. The vast majority of the interviewees used the abstracts as a highly valued screen, i.e., they used the abstracts to decide whether or not the whole articles was pertinent to their search. If it was, the whole document was almost always required. One exception claimed that the abstract, pertinent or not, contained sufficient information for his particular search.

Several problem areas were identified. Six people complained about the unavailability of journals (one installation does not subscribe to Chemical Abstracts and three of these people indicated that the interlibrary loan service takes 1 - 3 months. Requests for DDC documents are handled by a central library in 3 installations in which long delays are encountered in receiving requested reports. Some libraries circulate new journals which makes them unavailable to other users. Acquisitions of new texts and journals are thought to be too slow. Many libraries are not willing to buy multiple copies of frequently used texts for use as desk tools by individual scientists. The lack of photocopying devices for making hard copies of journal articles presents quite a problem to eight users. One user suggested that some central library might provide photocopies of specified articles.

Several people touched on problems of security classification. One user claimed that reports tend to be overclassified, one would like to see periodic reviews of classified subjects with references, and three made a plea for comprehensive indexing and abstracting of classified information.

Foreign literature seems to be another problem area. Eight users complained about difficulties in getting translations of foreign journal articles. One stated it would be helpful to have more informative abstracts of foreign literature.

Two scientists believed that the caliber of the government technical report should be improved, that they now are too much like progress reports to be of much value. Two also indicated that they would like TAB abstracts to be more informative than they now are.

Present indexing methods were attacked, too. One researcher questioned the adequacy of the hierarchical indexing employed today in printed indexes; six suggested that increased depth of indexing would be an improvement (one user, for example, experienced great difficulty in finding analytical methods in the present indexing systems when the analytical technique was not the primary subject of the article). However, although 26 users discussed background searches on classes of compounds, only three verbalized the need for a generic search capability.

Two users recognized chemical nomenclature as a basic problem, that is, they are not sure in searching a particular subject index that they have given the appropriate word name to their compound which will lead them to the references. One believed that review articles written periodically about classes of compounds was warranted, and finally, three expressed the hope that retrospective searching might be performed effectively by computers.

THE SPECIFIC SEARCH (Questions 13-17)

About 150 examples of searches for specific facts or data were compiled, the subjects of which are categorized in Table VIII. As related to chemical compounds, the characteristics of interest to more than one user were dielectric strength (2), solubility data (9), refractive index (2), infrared spectral data (4), melting point (5), stability (4), UV spectra (3), viscosity (2), toxicity (4), vapor pressure (2), and heats of formation (2). In connection with questions on materials, characteristics of major interest were specific heat, density, thermal conductivity, viscosity, and friction.

The time variation to complete these searches, presented in Table IX, was broad; as in the broad retrospective searches, the indicated time often was not continuous.

In descending order of frequency, tools and techniques used to locate this specific information were found to be textbooks or standard references (31), handbooks (Chemistry and Physics, Rubber, Machinists, Metals, Optics) (29), contact with manufacturing company (20), Chemical Abstracts thru subject index (19), Beilstein (17), contact with expert (16), International Critical Tables (14), specialized handbooks or commercially available data compendia (Sadtler, Color Index, Seidl's Solubility Data, Merck

Table VIII. SUBJECTS OF SEARCHES FOR SPECIFIC FACTS OR DATA

Subject	%
Chemical Compounds	
Compound(s) given; characteristics sought	31.2
Characteristics given; compound(s) sought	11.9
Existence of	3.4
Commercial source of	4.2
Methods of analysis for	2.1
Reactions of	4.2
Methods of synthesis for	2.1
Applications of	1.4
Materials	
Material given; characteristics sought	7.7
Characteristics given; material sought	4.9
Formulations of	2.1
Compatibility of with specific chemicals, fungi, etc.	3.4
Biological (nutrition of microrganisms, implications of a disease with an animal species)	2.1
Other	19.3

Table IX. COMPLETION TIMES OF SEARCHES FOR SPECIFIC DATA OR FACTS

Completion Time	%
Less than 30 minutes	25.0
One half hours - 4 hours	18.4
One half day - one week	20.3
One week - one month	9.6
Did not know	26.7

Index) (14), specialized information centers (12), (PLASTEC (3); Prevention of Deterioration Center (3); Toxicology Information Center (3); Chemical Propellants Information Center (1); Radiation Effects (1); Oak Ridge (1)); commercial literature on products (9), and government reports (9).

Nine users complained that small bits of information are often hidden and therefore elusive. The same number indicated that they have been forced occasionally to regenerate the data due to inability to find it. Three suggested that deeper indexing might help, while eight thought that the solution might be at hand by establishing highly organized data files for both classified and unclassified information. One interviewee believed that additional specialized information centers should be set up; several areas of coverage for such centers were suggested by others, namely, data on solubility, mass spectrometry, infrared spectra, gas chromatography and thermochemical data.

CURRENT AWARENESS (Question 18)

In order to maintain an awareness of current information in their fields, the users interviewed reported two general approaches: they scan literature and they attend scientific and technical meetings.

The scanned literature was broken down into four categories:

1. abstract journals, such as Chemical Abstracts, and other specialized abstract journals

2. commercially available alerting devices, i.e., Index Chemicus, Current Contents, Chemical Titles, and Current Chemical Papers.

3. Government published alerting devices - abstract journals, i.e., Technical Abstracts Bulletin, Nuclear Science Abstracts, and Space Technology & Aerospace Reports.

4. All other periodically issued publications, including trade, news, scientific journals, and newsletters.

Concerning primary journals, the interviewees scanned every issue of between two and twenty-seven periodicals, and read articles of interest. The total number of references to journals was 470, which gives an average of 5.8 journals scanned by each user. The total number of journals was 210, a complete list of which appears as Appendix B. It is not surprising that the heaviest interest was in the U. S. published journals, primarily the ACS journals.

Abstract journals were cited by a few in the current awareness discussions. Chemical Abstracts was mentioned by 8 users, and other specialized abstracts such as those of The Defense Metals Information Center and The Prevention of Deterioration Center, Corrosion Abstracts and Analytical Abstracts a total of 15 times.

Some interesting facts were uncovered about the use of commercially available alerting devices, specifically Current Contents, Current Chemical Papers, Chemical Titles and Index Chemicus. First, about 60% of the population used none of these at all. For the thirty-three who did scan these, Chemical Titles (14) and Current Contents (16) seemed to be about equally appealing. Understandably, due to its limited audience, Index Chemicus was mentioned by only six users (there were 17 organic chemists in the population). Current Chemical Papers was mentioned by three. The interesting point is that the use of alerting journals was limited to about half of the organizations visited.

The government publications-TAB, STAR, and NSA are not used to any greater degree than the commercial alerting tools. Representatives of 14 organizations mentioned using them; TAB apparently is much more widely seen than STAR or NSA, with actual figures of 26, 8 and 7 respectively.

Several individuals indicated that they participated in a cooperative current awareness team effort designed to minimize the individual reading requirement in which each member is responsible for covering certain journals, not only for his own interests, but for those of every other member in the group. Apparently, this arrangement is working to the satisfaction of three groups who use it.

The interviewees are members of between 0 and 7 of a total of 52 scientific societies, a complete list of which appears as Appendix C. Attendance at national society meetings ranged from 0 - 4 per year with a

mean attendance of a little less than 1/yr. Apparently, the breadth of coverage of many national meetings limits their value for many of the population. Twenty-eight indicated that they preferred to and do attend highly specialized symposia or seminars related to their work. Forty users believed that more valuable information was gathered at informal discussions held with other attendees at meetings than at the formal presentations. The value of meetings seems to be the presence of a high density of people with similar interests and problems and the chance for these people to exchange their viewpoints and approaches.

SERVICES (Questions 21-22)

The user was shown a card (see Table X) containing an illustrative list of services which could be offered by an information system.

Table X. SUGGESTED SERVICES AND INCIDENCE OF INTEREST

Service	No. Users Interested
1. A "Who's Doing What in Chemistry" Index	33
2. Advanced Schedules of Scientific Meetings	26
3. Selective dissemination of information in a particular field of interest	60
4. List of newly prepared chemicals	26
5. Summary reports of Proceedings of Scientific Meetings	41
6. Translations of foreign journal articles	56
7. File of commercially available equipment	21

He was told that numbers 3 and 4 were automatically distributed services and that the remainder were demand type services. He was asked to indicate which would be of interest to him. The figures following each service represent the number of users who expressed interest in it. Selective dissemination and translation services appealed to a large number of individuals, with summary reports of scientific meetings of interest to half. Some individuals modified the suggested services, for example, one believed that a periodic list of newly available biologicals would be valuable; another believed that, in conjunction with #5, that teams of scientists should be sent to foreign meetings of interest for the express purpose of reporting to those at home. The real purpose for showing this card was to encourage the individual to mention other services which would be valuable to him.

The interviewees suggested that an information system would be helpful if it would, for example 1) generate critical review articles or bibliographies, in specific fields, as reported in the open literature as well as government and contractor reports, 2) sponsor conferences in narrow subject fields attended by representatives from industry and government, 3) provide demand literature searches, 4) provide reprints of specific journal articles either in hard copy or microform, 5) establish an indexing and abstracting service for all classified literature, 6) organize and maintain central data or information files on, a) the availability and cost of rare and exotic chemicals and specialized materials, i.e., high purity single crystals, b) analytical techniques, c) dangerous or hazardous materials including mode of action, pathology, and toxicity, d) IR spectral data, e) UV spectral data, f) near visible spectral data, g) proposed government research projects with names and locations of the originators of the proposals, and h) a file on modern instrumentation, with an evaluation of the comparative performance of instruments for a specific purpose.

INFORMATION FOR CIDS DESIGNERS (Questions 23 - 30)

Regarding requests for references, the user was asked to express a preference of response format and desired response time. The choices offered appear in Table XI along with a scatter of the responses.

Table XI. DESIRED FORMAT AND RESPONSE TIME FOR REQUESTS FOR REFERENCES

CHOICES:
1. A summary or review prepared by the system
2. A group of whole documents which apply to your query
3. A bibliographic list of author, title, journal reference along with an abstract of the article
4. A bibliographic list of author, title, journal reference without abstract

	Desired Response Time												
Response	1 Hr	1 Day	2 Days	3 Days	5 Days	1 Week	10 Days	2 Wks	3 Wks	1 Mo.	6 Wks.	3 Mo.	
1				1		1		2					4
2			1			1		2		1	1		6
3		2	2		1	19	5	9	2	5			45
4													0
1 or 2								1					1
1 or 3						4		1			1	1	7
1, then 2								1		1			2
4, then 3, then 2	1	1		1		2							5
3, then 2			1	1		2	3	5				1	13
	1	3	4	3	1	29	8	21	2	7	2	2	

It should be noted that 20 of the users wanted some interplay with the system; that is for example, they wanted citations first, then selected abstracts, then selected whole documents. In the cases of the interplay responses (last 3 rows) the response time recorded is for the first reply. No one wanted only a list of citations; further, abstracts appeared to be desirable to a total of 70 of the users somewhere along the line. Several indicated that these should be quality abstracts, informative rather than indicative. One believed that it would be helpful to receive abstracts in a fileable form. Response times varied greatly (between 1 hour and 3 months); 85% of the users would allow at least a week's time to reply.

The importance of structural formulas as an output in a specific data search and the required response times was determined. Again, the given choices are shown in Table XII along with a scatter of the responses.

First, it should be noted that the questions were not applicable to two users, a foundry metallurgist and a mechanical engineer. The scatter then is based on the responses of 80 users. Eighty percent of the users wanted compounds represented by structural formulas; about 10% qualified this by indicating that they preferred structural formulas for organic compounds and molecular formulas or nomenclature for inorganic compounds. The 15% who were not interested in structures at all were largely inorganic chemists, chemical engineers, and food technologists. Concerning the desired response times, 95% of the users would be satisfied with a same-day response, about 85% with 24 hour responses, and 60% with a one-week response.

A pair of questions were asked to determine the "noise" tolerance and tolerance for overlooked pertinent material. Since the responses are meaningless independently, they were handled simultaneously. Table XIII shows the scatter of responses to these questions.

Thirty-three respondents (40%) would be satisfied with a reply containing only 50% of the relevant material existing on a subject. On the other hand, almost 25% of the users claim that they required 100% of the relevant material. (One such user defined 100% as that which could be uncovered by him in a search of Chemical Abstracts). Actually, the only important conclusion which can be drawn from the responses to these questions is that our users seem to be able to tolerate large amounts of irrelevant material easier than large amounts of unrecalled relevant material.

Table XII. DESIRED FORMAT AND RESPONSE TIME FOR REQUESTS FOR DATA ON COMPOUNDS

CHOICES: 1. Graphic representation (structural formula) plus property description
2. Standard nomenclature plus property description
3. Molecular formula plus property description

	Desired Response Time											
RESPONSE	1 Hr	Same Day	1 Day	2 Days	3 Days	4 Days	1 Week	10 Days	2 Weeks	3 Weeks	1 Mo	
1	1	7	5	4			16	2	13		1	49
2				2			4	2		1	2	11
3				1			2		1			4
1 and 2	1	1	1		1		2		1	1		8
2 and 3	1											1
1 or 2	1					1	1		1	1		5
1 or 3							2					2
	4	8	6	7	1	1	27	4	16	3	3	

Table XIII. USER'S TOLERANCE FOR "NOISE" AND OVERLOOKED RELEVANT MATERIAL

% Of All Relevant Material Which Must Be Provided

% Of Material Which Must Be Relevant	50	55	60	65	70	75	80	85	90	95	100	
100	1											1
95												-
90									1		1	2
85												-
80							1			1	2	4
75						1					1	2
70							1		1			2
65											1	1
60	1										1	2
55												-
50	4		1			1	1		3		2	12
45											1	1
40	2					1			1		1	5
35							1		1			2
30	3		1				1		1			6
25	3					1	1				1	6
20	4				1				1		2	8
15	1											1
10	12					1	1	1	2	1	3	21
5	2							1			2	5
	33	-	2	-	1	5	7	2	10	2	19	

Note: Numerals in scatter indicate number of users satisfied at that intersection.

The interviewees were asked to express an opinion as to whether or not data should be included which had not been published either in the open literature or as a government report. Eighteen users voted "no", commenting in some instances, that anything worthwile would have been published. One user qualified his "no" by saying that he would not care to take the time to contribute his data to such a system so therefore was against it. Of the sixty-four who wanted such data included, sixty indicated that the source should also be included so that some self-evaluation could be made of the adequacy of the data.

The CIDS needs to have some notion of traffic it might expect once it is operational. Figure 1 gives the estimated frequency of requests. Users reported that they estimate their requests will number between two and 2000 times per year with an average of 88 requests/user/year. If 5000 of the reported 13,500 government RDT&E scientists and technologists are interested in chemical information and data, CIDS then can expect slightly less than 450,000 requests/year. However, this projection presumes, as all the users interviewed have had to do, that CIDS will be able to answer all the questions they raise. It is somewhat sobering to know that the Air Force's Mechanical Properties Data Center, in its first year of operation, received information requests at the rate of between 0 and 5/month. Within the following two years, as more users became aware of their existence, their request rate increased as high as 25/month.[2]

EXAMPLES OF QUESTIONS (Question 31)

The final question in the interview requested that the user cite several examples of questions he might ask a CIDS. A total of 308 examples were collected, which appear as Appendix D. The questions were categorized in several ways.

A total of 27 questions had no bearing on chemistry; that is, they were technical questions but not answerable by CIDS. These questions were concerned with ballistic measurements, mechanical engineering, meteorology, aviation, ecology, and physics. (Examples are: questions #1, 12, 88, 95, 97, 98, 100, 104, 105, 106, 109-114, 123, 124, 149, 181, 232, 239, 240, 243, 244, 272, and 306.)

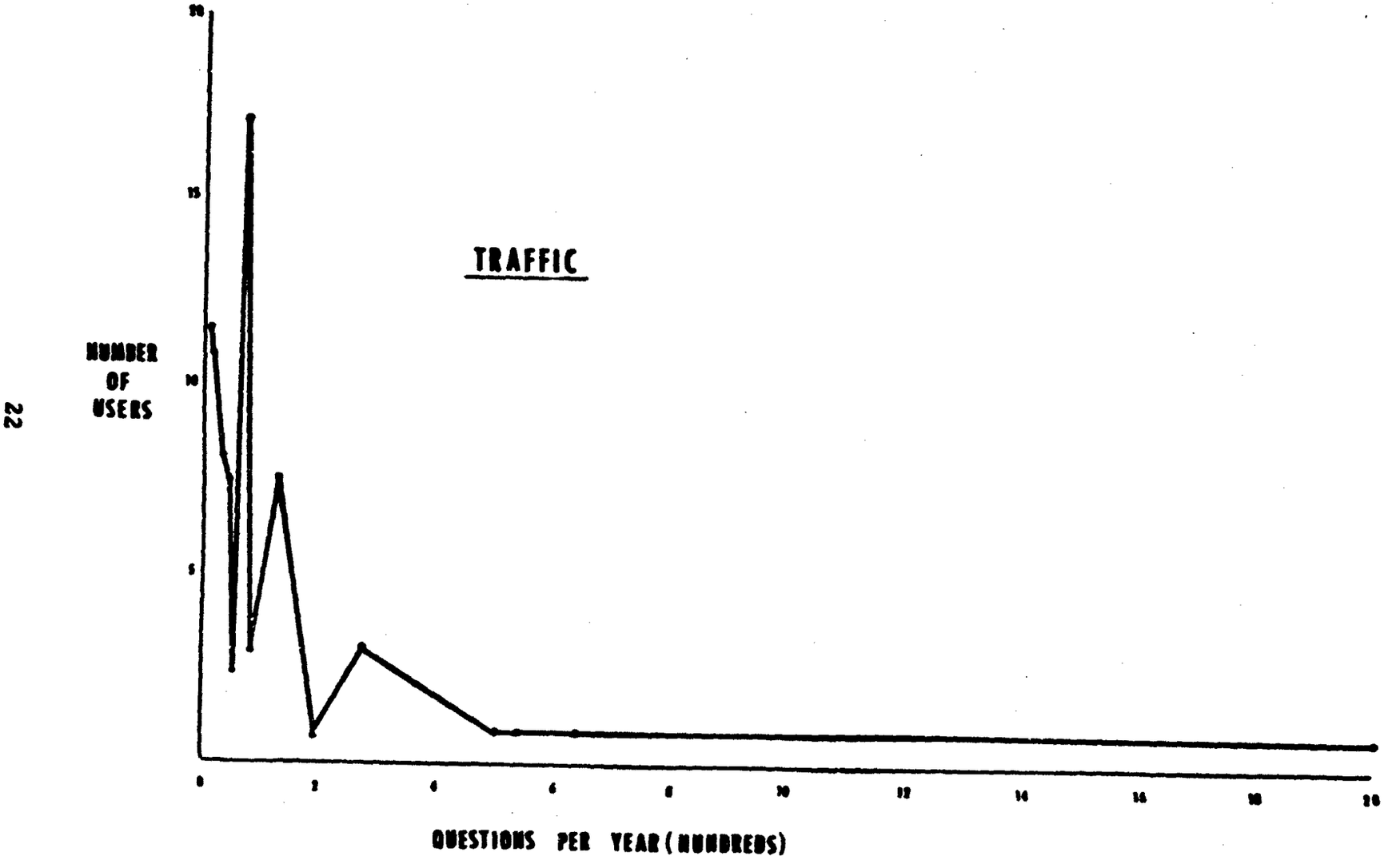

Figure 1. Estimated Frequency of Requests

The remaining 281 questions were categorized as chemical, i.e., they are believed to be questions which CIDS should be able to answer, within the limits of the scope. Eleven of these, however, are non-technical. Information such as commercial sources of chemicals, locations of individual scientists, and chemical curricula at universities was sought. (Examples are: questions #3, 59, 122, 125, 145, 163, 170, 214, 234, 273, 274.)

The other 270 were chemical, or chemically-oriented, and also technical. (Examples are all others which were not mentioned above.) For the remainder of the analysis, this latter category of 270 chemical technical questions will be the only one considered.

One subdivision was made into inorganic, metallurgical, and organic questions. A fourth category was needed to place those questions which were not sortable in any of the other three divisions due to the ambiguous nature of the question, i.e., What is the conductivity of material X?, or What are all known reactions of a specific compound?. Table XIV shows the details of this breakdown; it points up the heavy emphasis which can be expected in the field of organic chemistry.

Table XIV. CHEMICAL TECHNICAL QUESTIONS CATEGORIZED BY SUBJECT DISCIPLINE

Category	No. of Questions	% of Questions	Examples
Inorganic	19	7.00	2,5,6,11,121,135,143,157, 161,171,172,179,190,210, 217,278,279,280,303.
Metallurgical	25	9.25	73,74,168,169,175,178,180, 188,189,191-195,230,237,248, 249,282-284, 298-300,307.
Organic	146	54.0	7-10,14-20,25-37,41-58,60-70, 72,75-77,79-84,87,89-91,99, 102,103,107,108,115,116,130-132,139-142,150,152-156,159, 160,164-167, 183,185,187, 196,197,199,202-207,209,211, 212,216,218,219,228,229,231, 245,246,250,253-263,267-269, 281,286,287,289-295,297,301, 302,304,305.

Table XIV. (Cont'd)

Category	No. of Questions	% of Questions	Examples
Not identifiable in above categories	50	18.5	4,13,23,38-40,78,85,86,92-94,119,120,127-129,133,136,137,144,146-148,173,177,182,184,186,198,208,222-226,233,235,236,238,241,242,247,252,264,265,275-277,296.
Others	30	11.25	21,22,24,71,96,101,117,118,126,134,138,151,158,174,176,200,201,213,215,220,221,227,251,266,270,271,285,288,308.

A second division was made between questions requiring specific answers (not necessarily digital) and those requiring bibliographic answers: This breakdown is summarized in Table XV.

Table XV. CHEMICAL TECHNICAL QUESTIONS CATEGORIZED BY TYPE OF RESPONSE REQUIRED

Category	No.	%	Examples
Requires bibliographic response	65	24	5,22,23,46,49,50,52,53,61-64,71,80,81,91,101,118,121,126,128,138,144,151,153,157,160,162,168,169,172,175,180,182,188,189,192,194,201,203,210,213,215,218-221,230,231,237,238,248,251,258,260,261,263,266,270,280,285,288,292,298,308.
Requires specific answer	205	76	2,4,6-11,13-21,24-45,47,48,51,54-58,60,65-70,72-79,82-87,89,90,92-94,96,99,102,103,107,108,115-117,119,120,127,129-137,139-143,146-148,150,152,154-156,158,159,161,164-167,171,173,174,176-179,183-187,190,191,193,195-200,202,204-209,211,212,216,217,222-229,233,235,236,241,242,245-247,250,252-257,259,262,264,265,267-269,271,275-279,281-284,286,287,289-291,293-297,299-305,307.

According to this breakdown, an almost 3-1 ratio will exist in favor of questions requiring specific answers as opposed to bibliographic responses.

The questions were divided into those requiring an expert's evaluation or judgment and those not requiring such perusal. Table XVI summarizes this breakdown.

Table XVI. CHEMICAL TECHNICAL QUESTIONS CATEGORIZED ACCORDING TO THE NEED FOR EXPERT EVALUATION

Category	No.	%	Examples
Requires evaluation	21	7.8	7,10,16,19,24,40,48,84,96,118,153, 158,201,227,238,241,242,265,266, 298,304.
Requires no evaluation	249	92.2	2,4-6,8,9,11,13-15,17,18,20-23,25-39,41-47,49-58,60-83,85-87,89-94,99, 101-103,107,108,115-117,119-121,126-144,146-148,150-152,154-157,159-162, 164-169,171-180,182-200,202-213,215-226,228-231,233,235-237,245-264,267-271,275-297,299-303,305,307,308.

This breakdown indicates that a relatively small percentage of questions will require an expert's analysis to provide an answer. Over 90% of the questions should be able to be processed completely by support personnel.

A categorization was made of questions pertaining to chemical compounds, to materials, and others (concerned with equipment, mechanisms of action, biological phenomena, processes, etc. not related to any particular chemical compound or material.) Those questions concerning chemicals and materials were subdivided into two additional categories; 1) where identity of compound or material was given, and other information was sought and, 2) where other information was given and identity sought. This breakdown is found in Table XVII; it points out that about 17% of the questions received by CIDS are likely to be about materials, 68% about chemicals and 15% about other subjects.

Table XVII. CHEMICAL TECHNICAL QUESTIONS CATEGORIZED ACCORDING TO COMPOUNDS, MATERIALS OR OTHER CATEGORIES

Category	No.	%	Examples
A. Materials			
1. Identity of mat'l given: other information sought.	29	10.7	4,6,15,37,126,128-130,133, 136,167,184,188,191,193-195, 218,219,235,252,264,282,298-302,307.
2. Other information given: identity sought	16	5.9	13,73-76,137,147,178,185,187, 208,241,242,247,249,283.
B. Chemical Compounds			
1. Identity given: other information sought	126	46.8	2,8-11,14,17-19,22,23,25-29, 31-34,38-43,46,48-58,60,62,77, 82,83,85,89,91,93,94,120,131, 132,135,139-143,146,148,150-152,154,155,157,159-161,168, 171-173,175,177,189,190,196-199,202-205,209-212,222-224, 231,233,236,237,250,253-255, 257,258,260-263,267-269,275-280,284,286,287,289-291,293-297,305.
2. Other information given: identity sought	57	21.0	7,16,20,21,24,30,35,36,44,45, 47,63-70,72,84,86,90,92,99, 102,103,115,116,119,127,144, 156,164-166,183,186,192,206, 207,216,217,225,226,228,229, 245,246,256,259,281,285,288, 292,303,304.
C. Others	42	15.6	5,61,71,78-81,87,96,101,107, 108,117,118,121,134,138,153, 158,162,169,174,176,179,180, 182,200,201,213,215,220,221, 227,230,238,248,251,265,266, 270,271,308.

Finally, questions categorized as concerned with compounds (Table XVII, B) were divided according to whether or not a substructure search (or generic search) is required to produce the answers. This categorization is given in Table XVIII which shows that questions requiring no substructure search have a 3.5:1 predominance over those requiring such a search.

Table XVIII. QUESTIONS PERTAINING TO CHEMICAL COMPOUNDS CLASSED ACCORDING TO REQUIREMENT FOR SUBSTRUCTURE SEARCH

Category	No.	Examples
Requires substructure search	39	10, 14, 17, 18, 28, 32, 34, 41, 43, 46, 54, 57, 72, 82, 90, 94, 131, 132, 150, 159, 196, 197, 199, 202-205, 207, 212, 259, 261-263, 286, 287, 297, 303-305.
Requires no substructure search	144	2, 7-9, 11, 16, 19-27, 29-31, 33, 35, 36, 38-40, 42, 44, 45, 47-53, 55, 56, 58, 60, 62-70, 77, 83-86, 89, 91-93, 99, 102, 103, 115, 116, 119, 120, 127, 135, 139-144, 146, 148, 151, 152, 154-157, 160, 161, 164-166, 168, 171-173, 175, 177, 183, 186, 189, 190, 192, 198, 206, 209-211, 216, 217, 222-226, 228, 229, 231, 233, 236, 237, 245, 246, 250, 253-258, 260, 267, 269, 275-281, 284, 285, 288-296.

SUMMARY

The present survey supports the opinions expressed by others (Jahoda[4]) that users cannot described their information needs in terms of what innovations in information handling methods will be most helpful to them. They are restrained in thinking of information services as they now know them. However, within the framework of information services now known to users, some interesting conclusions seem apparent.

In a retrospective search, the value of quality abstracts was emphasized by users as a screening device to judge the usefulness of a whole document. The lack of interest in lists of citations as an output to a search was demonstrated. A capability for providing hard copy of reports or journal articles is desirable. In these requests for references, the user is better able to tolerate large amounts of irrelevant material than large amounts of overlooked material.

In providing data per se rather than references to where data may be found, the user is generally unwilling to receive the data without an accompanying reference. In such requests, organic chemical compounds should be displayed by structural formula, whereas inorganic compounds by nomenclature or molecular formula.

Although desired response times vary greatly, 85% of the users would be satisfied with 24-hour response time for data requests, and one-week response time for retrospective searches for references.

It is apparent that users of chemical information are not well educated as to existing services available today. It is recommended therefore that an active education campaign be undertaken to acquaint the user with services and tools accessible to him now.

Finally, it is suggested that the present study be considered a preliminary user need study, and that an additional similar effort, made after an experimental CIDS is implemented, be required to provide a more adequate record of user needs.

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APPENDIX A

INTERVIEW GUIDE

For the past few weeks I have been conducting a survey for the Chief, R & D, Department of the Army. You may have heard that the Army is planning to establish an information retrieval system in the field of chemistry to combat the negative effect that the recent information explosion has had on the adequate transmittal of knowledge. We are trying to determine just what a successful chemical information and data system should include. We feel that we can establish the minimum requirements for our system by learning in detail how people like yourself, who need chemical information and data, actually go about getting it.

Before I continue, I'd like you to give me some personal vital statistics.

Name _____ Academic Degrees:

Job Title _____ B.A. (B.S.) _____

Grade _____ M.S. (M.A.) _____

Installation _____ Ph.D. _____

Mission _____

Total Professional Experience _____ years

Experience in Present Job _____ years

Now I'd like you to think in terms of one particular search for past information that you have made recently, say, within the past year. Choose one the details of which you remember fairly well. (Pause - if interviewee appears confused, add) If it is difficult to think of a search, alone, that is, without a frame of reference, perhaps it would be easier to think of a specific task or assignment which required that you look up information or data to complete it.

1. Why were you seeking this information? (or)
What was the task or assignment which required you to make this search?

2. What was the subject of the search?

3. At the start of the search, did you have any knowledge of the subject? Yes _____ No _____

4. Did you perform the search yourself? Yes _____ No _____

5. How did you go about getting this information? That is,

   a. What tools and techniques did you use to make this search?

   b. Did this source supply you with references to articles, abstracts, or specific data or facts?

   c. What information did you get from this source?

   d. How far back did you go in your search of this source?

a	b	c	d
Tool or Technique	Form of Info	Description of Info	Search last ____ years

6. Are these tools and techniques those you usually use in making a search of this kind? Yes _____ No _____ (if no) How are they different?

7. Did these tools and techniques supply you with the information you required? Yes _____ No _____

8. How long did it take you to make this search? _____

9. Did you get the information in time for it to be useful to you?
Yes _____ No _____

10. Can you describe any problems you encountered in this search?

11. Can you suggest any solution to this problem?

12. Can you suggest any other improvements?

Now I'd like you to focus your attention on instances when you were searching for a specific fact or facts.

13. a. What specific fact or data were you looking for?

    b. What tools or techniques did you use in making this search?

    c. How recent would this information have to be to be of value to you?

    d. Did this source supply you with the data?

    e. How long did it take you to find this information?

a	b	c	d	e
Fact/data Sought	Technique or tool	How recent	Was data supplied	Time search took

14. Are these tools & techniques those you typically use in searching for specific data? Yes _____ No _____ (if no) What is your typical approach?

15. Can you describe any problem you encountered in making these searches?

16. Can you suggest any solution?

17. Can you suggest any other improvements?

The problem of being informed is a twofold one: one phase has to do with past information, which we have just discussed. The second has to do with awareness of what is being done currently.

18. What tools and techniques do you use to keep aware of current information related to your work?

Tool or Technique	
Journals	Frequency read
Scientific Society Memberships	Attendance at Meetings
Alerting Devices	Frequency used

19. Do you keep any reference files? Yes _____ No _____
(if yes) a. Do you have an index? _____Yes No _____
(if yes) b. What kind of index?
c. How many items are included? _____

20. Do you have any other reference or specialized files available to you? Yes _____ No _____
(if yes) What subjects are included in these files?

21. Here are a list of services. (Present card) Which of these do you think would be valuable to you? _____ _____ _____ _____

1. A "Who's Doing What in Chemistry" Index
2. Advance Schedule of Scientific Meetings
3. Selective dissemination of information in a particular field of interest.
4. List of newly prepared chemicals
5. Summary reports of Proceedings of Scientific Society Meetings
6. Translations of foreign journal articles
7. File of commercially available equipment

22. Can you think of any other services that you think would be valuable?

In the beginning of our talk, I mentioned that the Army is planning to establish and operate a chemical information and data system. The scope of the system has been defined only partially to date. However, it has been established that one of the files which will be maintained is a chemical structure file of all compounds known to exist. This will allow a chemist to know whether or not a compound has already been synthesized. We hope to provide two kinds of services for retrieving information of the past, i.e., one which supplies references to work already done, and the other which supplies the actual facts or data.

23. If you wanted information in the form of references to work already done, in which of the forms listed on the card would you prefer to have a reply? (Show Card) _____

1. A summary or review prepared by the system
2. A group of whole documents which apply to your query
3. A bibliographic list of author, title, journal reference along with an abstract of the article
4. A bibliographic list of author, title, and journal reference without abstract

24. What do you feel would be a reasonable period of time to expect a reply to a request of this kind? _____

25. If you wanted data, i.e., all compounds having a specific property within a certain range, in what form would you prefer to have a reply? (Show Card) _____

1. Graphic representation (structural formula) plus property description
2. Standard nomenclature plus property description
3. Molecular formula plus property description.

26. What do you feel would be a reasonable period of time to expect a reply to a request of this kind? _____

27. Now let's assume that you have made a request for references to journal articles on a specific subject, and have received as a reply 10 references or articles. Due to the depth and accuracy of the techniques which were used to index each article orginally, some of these references will have more pertinence to your needs than others. Will you indicate, please, what percentage of pertinent articles must be present in order for you to feel satisfied with the service? _____

28. Now let's assume that you have made a request for a bibliography on a specific subject for which a total of 10 references or articles exist, and our system is able to provide you with a list of five of these, would you be satisfied with this service? Yes _____ No _____
(if no) With what number would you have been satisfied? _____

29. Do you feel that this system should include data which has not been published either in the open literature or as a government report?
Yes _____ No _____

30. Assuming that a convenient means is available to you for contacting this system, will you estimate please the frequency of your requests?

_____

31. Can you give me several examples of questions which you might pose to an information and data system in chemistry?

APPENDIX B

SCIENTIFIC & TRADE JOURNALS, BULLETINS, TRANSACTIONS, ETC. SCANNED BY USERS WITH INCIDENCE OF USE

Acta Crystallographica	1
Acta Metallurgica	1
Adhesives Age	2
Advanced in Food Research	1
Advanced in Physics	1
Aerospace Medicine	1
American Journal of Physiology	1
American Scientist	1
A.S.M. Review of Metals	1
Analyst	2
Analytical Chemistry	24
Analytica Chemica Acta	3
Angewandte Chemie	3
Applied Mechanics Reviews	1
Applied Spectroscopy	3
Archives Biochemistry & Biophysics	3
Astronautics & Aeronautics	2
Auk	1
Australian Science	1
Aviation Week	1
Biochemica Biophysica Acta	4
Biochemical Journal	4
Biochemistry	4
Biophysical Journal	1
British Journal of Applied Physics	1
Bulletin of the Franklin Institute	1
Business Week	1
Canadian Journal of Chemistry	2
Canadian Journal of Physics	1
Chemical & Engineering News	16
Chemical Engineering	8
Chemische Berichte	2
Chemistry in Industry	1

Chemical Process Engineering	1
Chemical Progress	2
Chemical Reviews	2
Chemical Week	4
Clinical Chemistry	1
Clinical Pathology	1
Computer Reviews	1
Condor	1
Corrosion	3
Defense Metals Information Center Bulletin	1
Design	2
Design Engineering	1
Design News	2
Electrical Engineering	1
Electrochemical Technology	1
Electronics Design	1
Experimental Mechanics	1
Food Engineering	1
Food Field Report	1
Food Processing	1
Food Technology	1
Founderie	1
Foundry Trade Journal	1
Gas Chromatography	1
Helvetica Chemica Acta	2
Hydraulics	2
India Rubber World	1
Industrial & Engineering Chemistry	6
Industrial Engineering	1
Industrial Finishing	2
Industrial Research	4
Instrument Society of America Transactions	2
Insulation	2
Iron Age	2

Journal of the American Academy of Forensic Sciences	1
Journal of the American Chemical Society	31
Journal of the American Foundry Society	1
Journal of the American Nuclear Society	3
Journal of the American Physical Society	3
Journal of the American Rocket Society	3
Journal of the American Society of Corrosion Engineers	1
Journal of the American Society of Lubrication Engineers	1
Journal of Applied Physics	5
Journal of Applied Physics (Japan)	1
Journal of Applied Polymer Science	1
Journal of Applied Radiation & Isotopes	1
Journal of Applied Toxicology	1
Journal of the Association for Computing Machinery	1
Journal of Bacteriology	1
Journal of Biological Chemistry	7
Journal of Chemical Education	5
Journal of Chemical Engineering Data	1
Journal of Chemical Physics	7
Journal of the Chemical Society	3
Journal of Chromatography	1
Journal of the Electrochemical Society	5
Journal of the Electroplaters' Society	1
Journal of Food Science	1
Journal of Gas Chromatography	2
Journal of General Chemistry of U.S.S.R.	1
Journal of the Health Physics Society	1
Journal of Heterocyclic Chemistry	1
Journal of the Indian Chemical Society	1
Journal of Inorganic Chemistry	4
Journal of Inorganic & Nuclear Chemistry	2
Journal of the Institute for Metals	2
Journal of the Iron & Steel Institute	1
Journal of the Japanese Chemical Society	2
Journal of the Less Common Metals	1
Journal of Lipid Research	1
Journal of Mammology	1
Journal of Medicinal Chemistry	3

Journal of Metals	1
Journal of Molecular Spectroscopy	1
Journal of the National Lubrication & Grease Institute	1
Journal of the Oil Chemists Society	1
Journal of the Optical Society	1
Journal of Optics & Spectroscopy	2
Journal of Organic Chemistry	17
Journal of Physical & Chemical Solids	2
Journal of Physical Chemistry	13
Journal of Physiology	1
Journal of Polymer Science	5
Journal of Research, NBS A	1
Journal of Research, NBS C	1
Journal of Scientific Instruments	3
Journal of Wildlife Management	1
Light Metals	1
Machine Design	3
Materials (N.A.C.E.)	1
Materials and Methods	1
Materials in Design Engineering	3
Materials Protection	1
Mechanical Engineering	1
Metal Finishing	2
Metal Finishing & Plating	1
Metal Industry	1
Metal Working News	1
Metallurgia	1
Metallurgical Reviews	1
Metallurgy	1
Metals Engineering Quarterly	1
Metals Progress	1
Microchemica Acta	1
Micrologia	1
Missiles & Rockets	2
Modern Metals	1
Modern Packing	1
Modern Plastics	5

Nature	5
Naturforschung	1
Naturwissenschaften	1
Non-Ferrous Technology	1
Nuclear Engineering	1
Nuclear Instrumentation	1
Nucleonics	2
Oil & Gas Journal	1
Organic Finishing	1
Organic Reviews	1
Petroleum Refiner	2
Pharmacological Reviews	1
Phillips Research Reports	1
Phillips Technical Reviews	1
Philosophical Magazine	1
Physical Review Letters	2
Physical Reviews	4
Physics of Metals & Metallography	1
Physiological Reviews	1
Plastics	1
Plastics Design & Processing	1
Plastics Engineering	1
Plastics Technology	2
Plastics World	3
Plating	3
Polymer	1
Polymer Chemistry	1
Proceedings of the Chemical Society (London)	4
Proceedings of the National Academy of Science	1
Proceedings of the Royal Society of London	1
Proceedings of the Society for Experimental Biology & Medicine	1
Proceedings of the World Society	1
Product Engineering	4
Products Finishing	2
Quarterly Reviews	2

R & D	2
Radiation Research	3
Research Communications	1
Review of Modern Physics	1
Review of Scientific Instruments	2
Rubber Chemistry & Technology	3
Rubber Age	5
Rubber World	2
SAE Journal	1
Scandanavian Chemica Acta	3
Science	11
Science & Technology	1
Scientific American	4
Scientific Lubrication	1
Solid State Design	1
Soviet Rubber Technology	1
Spectrochemica Acta	3
Spokesman	1
Sylvania Technologist	1
Test Engineering	1
Tetrahedron	3
Tetrahedron Letters	3
Transactions of the American Society of Lubrication Engineers	3
Transactions of the American Society for Metals	3
Transactions of the Faraday Society	2
Transactions of the Metals Society (AIME)	3
Transactions of the New York Academy of Sciences	1
U.S.S.R. Journal of Physical Chemistry	1
Wall Street Journal	1
Wear Journal	1
Wildlife Disease Association Newsletter	1
Wilson Bulletin	1
World Oil	1

APPENDIX C

SOCIETY AFFILIATIONS AND INCIDENCE OF MEMBERSHIP

Academy of Forensic Sciences	1
Aerospace Medicine Association	1
American Association for the Advancement of Science	10
American Chemical Society	50
American Electroplaters' Society	3
American Foundry Society	1
American Institute of Aeronautics & Astronautics	3
American Institute of Chemical Engineers	2
American Institute of Chemists	2
American Institute of Mechanical Engineers	2
American Nuclear Society	1
American Ornithologists' Union	1
American Physical Society	1
American Physological Society	2
American Public Health Association	1
American Society Biological Chemists	3
American Society of Clinical Pathologists	1
American Society of Lubrication Engineers	3
American Society of Mammoiogists	1
American Society for Metals	4
American Society of Microbiologists	2
American Society for Testing Materials	7
American Society of Tool Engineers	1
American Society of Zoologists	1
Association for Computing Machinery	1
Association of Military Surgeons	1
Biophysical Society	1
British Institute for Metals	1
Candy Technologists of America	1
Chemical Society of London	1
Coblentz Society	1
Cooper Ornithological Society	1
Crystallographic Society	1

Defense Subsistence Association	1
Electrochemical Society	2
Electron Microscope Society of America	1
Faraday Society	1
Federated Societies for Experimental Biology	2
Health Physics Society	1
Institute for Food Technology	1
Instrument Society of America	1
Mathematics Association of America	1
New York Academy of Sciences	2
National Association of Corrosion Engineers	1
Radiation Research Society	3
Society for Applied Spectroscopy	2
Society of Automotive Engineers	1
Society for Experimental Stress Analysis	1
Society of Industrial Microbiologists	1
Vacuum Society of America	2
Wildlife Disease Association	1
Wildlife Society of America	1

APPENDIX D

EXAMPLES OF QUESTIONS

1. What high vacuum techniques are suitable for measuring velocity in guns?

2. What methods have been used for the analysis of stabilized red phosphorus?

3. List all manufacturers of red phosphorus.

4. What is the conductivity of material X?

5. Provide bibliography on irreversible thermodynamics of periodic reactions.

6. What are the solubility, e.m.f., temperature dependence and reactivity of chlorine electrodes?

7. What are all synthesis techniques of materials with potential use as thin films?

8. What procedure can be used for preparing impurity-free ferric ethylate?

9. Where is ferric ethylate available commercially?

10. What are the details of a vapor transport method suitable for growing single crystal ferrites?

11. What is known about the brightness of phosphorus in very short excitation times, i.e., nanoseconds?

12. What is known about the work functions of semiconductors?

13. What cleaners or decontaminants can be used to remove coatings from expensive electronic parts which are salvageable?

14. What are the boiling points of all isomers of compound X?

15. What is the thermal stability of Lubricant Z?

16. What is a good scintillator that does not contain hydrogen?

17. What is the biological activity of various classes of compounds?

18. Do patents exist on a specific class of compounds?

19. How does the presence of substructure X affect the biological activity of a group of compounds?

20. What compounds are inherently heat resistant at certain high temperatures?

21. Where are new deterioration inhibitors available?

22. What is known about preparative radiation chemistry on 2 component systems (gas phase)?

23. What is known about the surface properties of explosives?

24. Is there any relationship between surface energies and bulk properties of solids?

25. Has a particular reaction ever been carried out?

26. What are the characteristics of the product of a specific reaction?

27. What are the conditions of a particular reaction?

28. Provide all kinetic data on rates of reactions on alkyl isocyanates with aliphatic amines in catalyzed and non-catalyzed systems?

29. What is the solubility data for CO_2 in dioxane or other organic solvents over a wide range of temperatures?

30. What work has been done in the field of gas chromatography on propellant plasticizers (both inert and high-energy)?

31. What is a synthesis procedure for a particular organic propellant compound?

32. What are certain chemical and physical properties and applications of a series of compounds?

33. What is known about phase transformations of HMX?

34. What is known about the electrical properties of nitroamines?

35. Has anyone used an electron microscope to study the crystal properties of organic explosives in radiation damage studies?

36. What, if any, optical studies have been done on organic explosives?

37. How do tetrahydrofuran and methyl ethyl ketone affect the electrical, chemical, and physical properties of a particular plastic?

38. What are the characteristics of a specific compound during a vapor phase chromatography determination (elution time or temperature on a specific column)?

39. What is the polarographic activity of a particular compound?

40. What are the potential impurities of a compound which was prepared in a certain manner?

41. What information has appeared in the past year on the following classes of structures: tropenes, quinalizadines?

42. Has a specific compound ever been synthesized?

43. Has a Prinz reaction ever been performed on unsaturated cycloamines?

44. What biological effects have been observed on any family of compounds which are being studied anywhere in the government except E.A.?

45. What is the likely toxic ingredient of poison arrows used by Indians in Southeast Peru?

46. What has been published on the intravenous toxicity of a specific family of related compounds?

47. What, if any, reactions are known between organic compounds and the chlorate ion?

48. What, if any information is known about the isotopic effects in hydrogen abstraction by diphenylpicrylhydrazyl?

49. What is known about isotherms for adsorption of amines by charcoal from aqueous solutions?

50. What has been published in last three years on the subject of cholinesterase?

51. What are the distribution coefficients of pinacolyl alcohol?

52. What information has been published in last three years on pinacolyl alcohol?

53. What has been done on the use of borates in the hydrolysis of phenacyl biomide?

54. What reactions are known about $R-\overset{O}{\overset{\|}{C}}-CH_2Br$ compounds?

55. Has a specific compound or class of compounds been made?

56. What are the ionization constants, melting points, reaction rate constants, & specific solvent systems for specific compounds, X, Y and Z.

57. What are the physiological or pharmacological effects of a particular class of compounds?

58. What methods are known for the synthesis of a specific piperadinol?

59. Where is a specific compound available commercially?

60. Has a specific compound ever been synthesized?

61. Prepare bibliography on Botulism.

62. Prepare bibliography on Staphyloccal enterotoxins.

63. Prepare bibliography on paralytic poisons occurring in shellfish.

64. Prepare bibliography on toxins produced by pseudomonas cocovenans.

65. What are the modes of action of diphtheria toxins, tetanus toxins, and Botulinas toxins?

66. What is the mechanism of action of poisons from newts or California salamanders?

67. What toxins have been isolated from dinoflagellates and what is their mechanism of action?

68. What toxins are produced by Clostridium perfringens?

69. What toxic substances are found in marine fishes?

70. What toxic substances are produced by fresh water algae?

71. What references within the last 2 years are concerned with diffusion in gels?

72. What plastics are known which do not contain halogens and urea compounds and have a specific set of physical characteristics?

73. What metal alloys have a set of specific characteristics?

74. What alloys are compatible with microorganisms?

75. What elastomers are compatible with microorganisms?

76. What plastics are compatible with microorganisms?

77. Have specific peptides been prepared?

78. Who has used a specific analytical technique?

79. What methods are used to determine the presence of a certain functional group?

80. What information is available on the analysis of animal viruses?

81. What information is known on iron transport in biological systems?

82. What compounds related to amino acid histidine are capable of tying up Fe^{++} or Fe^{+++}?

83. What reactions occur when cysteine is held at pH 5-8 at temperatures of 0-45°C. in pure form, and in the presence of sugars and other amino acids?

84. What solvents are suitable for the field dissemination of chemical agents?

85. What are the M. P., B. P., and refractive index of specific compounds?

86. What are all known chemicals which produce a reaction of sneezing or eye irritation?

87. What types of equipment are used to determine the effectiveness of a chemical agent in the field?

88. What statistical methods are suitable for determining the significance of scientific data?

89. What solvents have a given boiling range?

90. What compounds have structures similar to a specific chemical agent?

91. What quantum chemistry has been done in the past year on substituted cyclopropenes?

92. What compounds are known which have specific gravity, viscosity range, and surface tension?

93. What analytical reactions are known for specific substances?

94. What chemical reactions occur between two compounds or two classes of compounds, and what are the reaction conditions?

95. What mathematical relationships are usually associated with physical chemistry (i.e., Beer's Law for light travelling through a cell of uneven thickness)?

96. What apparatus exists for passing a thin layer of liquid over both sides of a tubular membrane?

97. What multi-channel pumps operate in a range of 1-10 ml/min. ?

98. What systems exist for the magnetic recording of analytical read-outs?

99. What are the kinetics of enzymatic reactions involving simultaneous denaturation and regeneration of enzymes?

100. What is the ozone concentration in various geographic areas?

101. What information is known about the UV spectra of sunlight?

102. List all known non-ionic disinfectants.

103. What are the properties of gases which are used as disinfectants?

104. What are the meteorological characteristics of a specific geographical area?

105. What is the occurrence of a specific disease in a certain geographical area?

106. What is the soil type in a certain geographic location?

107. What is the decay rate of a pathogenic microorganism when aerosolized?

108. What is the effective dose (ID_{50}) of a certain bacterial or viral agent?

109. What is the rate of fuel consumption for a specific tactical aircraft at various altitudes?

110. What aeronautical regulations exist for operating an aircraft in a given area?

111. What is the ecology of a certain geographic area?

112. What species of birds and/or mammals are found in a specific geographic location?

113. What arthropods of public health interest are associated with specific birds or mamals?

114. What involvement is known about certain birds and mamals with known endemic diseases?

115. What compounds are known to have repellancy for leeches, insects, etc.?

116. What compounds are known to act as attractants for, or to excite animals?

117. What factors affect ion transport across living membrances?

118. What is known about the mechanism of olfaction?

119. What pyrophoric compounds exist which might be useful as incendiary agents?

120. What are all reactions of a specific compound?

121. What are all known methods for desalinating water and what are their comparative efficiencies?

122. What is the location of a specific scientist or explorer?

123. How is water frozen on the western edge of the Sudan?

124. Using water in a evaporative cooling process, what is the ratio of processed water to ice produced at sea level in the desert?

125. Where is a translation available of a foreign article?

126. What has been done in the last year on the spectroscopic analysis of coatings?

127. What compounds soluble in alcohol have IR absorption peaks at a certain wave length?

128. What work has been done in the past two years on a specific material?

129. Is a particular material applicable for a particular purpose?

130. Who is working in the field of brake fluids?

131. What methods of synthesis are useful for a specific class of compounds?

132. What are the chemical and physical properties of a class of compounds?

133. What are the effects, in vacuum and not, of radiation on a specific material?

134. How is "g" value influenced by temperature, and pressure?

135. What are the diffusion rates of one metal into another when one is being evaporated on the other?

136. What are the physical characteristics of a basic nuclear material?

137. What column material should be used in the chromatographic analysis of a specific material?

138. Provide bibliography on thin films.

139. Has a specific structure been made?

140. What are the characteristics which are known about a specific structure?

141. What synthesis procedures have been used to make compound X?

142. What reactions have been recorded about a specific compound?

143. What is the compatability of a specific chemical with metallic and non-metallic materials of construction?

144. What recent advances have been made in the determination of particle size distribution of liquid and solid chemicals?

145. Where is a specific chemical available commercially?

146. What is the vapor-liquid equilibrium data on a specific pair of compounds?

147. What materials would resist the corrosive nature of a specific chemical?

148. What are the details of a chromatographic analysis of a specific chemical?

149. Provide bibliography on the statistical design of experiments.

150. What are the reactions known for a functional group X?

151. Provide bibliography on Beckman rearrangements.

152. What is the synthesis of compound X?

153. Provide review on heterocyclic chemistry.

154. Does compound X exist?

155. What are the characteristics of compound X?

156. List all known naturally occurring fatty acids.

157. What recent developments are known on the use of lithium aluminum hydroxide as a reducing agent?

158. What correlations exist between mass spectra and ion fragments and structure?

159. What are the gas chromatographic retention times of a homologous series of structures?

160. What references are available to food products which contain certain identified chemical compounds, X, Y and Z?

161. What information is available about the effects of radiation on aqueous solutions of specific salts?

162. What references are known which mention a specific "g" value for a dosimetry system?

163. Please provide a copy of a specific whole document.

164. What are the fatty acid components of almonds?

165. What is the redox potential of volatile aromatics present in peaches?

166. What types of compounds are formed in the irradiation of beef?

167. What are the flavor constitutents of passion fruit?

168. What phase diagrams have been generated in the last three years on hydrogen metals systems?

169. Please prepare a bibliography on nuclear magnetic resonances studies of hydrogen in metallic elements.

170. Where is a single crystal of X metal available commercially?

171. What thermochemical data, physical properties, and crystal structure data are available on selected inorganic chemicals?

172. What studies have been done on optical interference in calcium fluoride?

173. What methods are suitable for the preparation and purification of a specific compound?

174. What instrumental techniques are suitable for measuring certain characteristics?

175. What methods are available for the analysis of beryllium in alloys.

176. What industrial companies are working on a particular analytical method?

177. What are the analytical applications of a particular chemical? For example, are interferences produced which influence reactions?

178. What material is available as a suitable coating for ECM electrodes?

179. What procedures can be used for filtering large volumes of iron hydroxide with high flow rates?

180. What are the newest techniques available for automating metal finishing operations?

181. What is known about sound attenuation?

182. What is known about anionic water soluble thickeners (mostly naturally occurring) with possible application in electrodeposition?

183. What is the occurrence, availability and monomeric structures of polyester resins resistant to high temperatures?

184. What are the properties of a specific material?

185. What plastic material is available which has a low distortion value at a certain temperature?

186. What information, (specifically what catalysts, fillers, and chemicals are used), is available on glass bedding compounds?

187. What thermoplastic resins are resistant to high temperature?

188. Provide bibliography on the effects of anodized coatings on stress corrosion.

189. Provide bibliography of all work done on the anodic treatment of magnesium.

190. What is the lattice constant of tantalum suboxide (TaOy and TaOx where x and y are varied)?

191. What is the composition of the oxide scale of a specific iron alloy?

192. What is known about the intersurface reaction of gas and metal at pressures ranging from room pressure to 100,000 psi?

193. What are the tensile properties of all Ti-base alloys?

194. What information is known about the effects of thermochemical treatments on the properties of steel?

195. What is the effect of high strain rate on the properties of steels?

196. What reactions are known for all nitrogen-fluorine containing compounds?

197. What is the source of supply of an N-F compound with a 10-carbon residue, and with a primary, secondary, and tertiary functional group?

198. What is the stability of compound X?

199. What complexes are formed with inorganic molecules and N-F compounds?

200. What mathematical methods have been used to correct for matrix effects in X-ray fluorescence analysis?

201. What multiple regression analysis techniques can be applied to X-ray fluorescence analysis?

202. What 3-membered ring compounds exist?

203. What infra red vibrational spectra work has been done on 3-membered ring compounds?

204. What structural studies (det'n of bond length) have been done on 3-membered ring compounds?

205. Where are 3-membered ring compounds available and what are the handling characteristics of these materials?

206. What phosphors are available which have a broad absorption band and narrow emission band?

207. What compounds of 6 or less atoms are available which have a frozen matrix configuration? What methods were used to determine this condition? What, if any, theories have evolved from this work?

208. What insulation material is available which, at a thickness of 10 mils, will withstand a temperature of 1200°F for 1 second?

209. What are the physical properties and resistance to environments (temperature extremes, wind, sand, snow and rain) of epoxy-metal structures?

210. What is known about boron fibers; how are they made, what are their properties, and applicability as reinforcing materials for plastics?

211. What is the volatility of a series of commercially available plasticizers?

212. What toxicity information is available on a group of fluorocarbons?

213. What is known about chemical bond energies?

214. Where can I get a specific compound?

215. Provide bibliography of infra-red techniques for determining hydrogen bonding.

216. List all low temperature polymerization catalysts for acrylate polymerization.

217. List all compounds suitable as catalysts for the decomposition of ammonium perchlorate.

218. What research and development is going on in the field of additive systems for fuels and lubricants?

219. What work is in progress in the field of engines and automotive components involving new lubricants, fuels and power transmission fluids?

220. What friction and wear studies are being done now?

221. What is the chemistry of engine combustion?

222. What is the vapor pressure of a specific compound?

223. What is the half life of a particular compound?

224. What are the IR and UV spectra of a specific compound?

225. What compound gives an IR spectrum which resembles a given specific IR spectrum?

226. What compound gives a scintillation spectrometry gamma ray spectrum resembling a given such spectrum?

227. Prepare an up-to-date version of a table of isotopes as appeared in Rev. Modern Phys. 30, April, 1958.

228. What paraphenlyenediamine derivative sublimes but also has a low vapor pressure?

229. What compounds exist with a hydrogen density higher than that of polyethylene?

230. What is known about coating processes in metals?

231. What is known about fabrication processes of polyethylene?

232. What is known about the ballistics of double walled structures?

233. What methods of synthesis are known for compound X?

234. Where is a specific compound available and at what cost?

235. What is the formulation of a specific proprietary materia ?

236. What instrument methods are known for the analysis of various compounds?

237. What is known about the corrosion of specific metals?

238. What is known about the relation of rupture problems as related to crystal structure?

239. What is known about the percentage increase of fatigue strength of πr threads when turned, ground, and rolled?

240. What is the effect of the size of a screw thread on the strength of the screw?

241. What materials with what hardnesses are best suited for immediate contact when submerged in MIL-O-5606 recoil oil?

242. What type hydraulic and pneumatic packings are best for pressures below 100 psi, between 100-500 psi, and between 500-1000 psi?

243. What transducer records a certain frequency under certain conditions of temperature, pressure, humidity and vibrational frequency?

244. What new means is available for measuring initial artillery displacement?

245. What methods are used for determining the permeability of gases through oil?

246. Who is working on the problem of permeability of gases through oil?

247. What materials are available for the protection against corrosion of rocker panels and door panels in vehicles?

248. Prepare bibliography on the stress corrosion of steel.

249. What spot tests are known for supplementary chrome finishes on aluminum?

250. What are applications suggested for nylon coatings on aluminum which yield low friction characteristics?

251. Provide bibliography on flame deposition of coatings using plasma jet techniques.

252. What is the composition of a particular proprietary chemical formulation?

253. What are the transition temperatures of specific greases?

254. What is the effect of grease structure on fret corrosion?

255. What methods are known for the identification of oxidation products of a specific grease?

256. What catalysts are available for setting a resin without the application of heat?

257. Has a particular compound been made, by whom, and how?

258. Prepare a bibliography on the nitration of aliphatic compounds using a particular reagent.

259. List all compounds which contain a specific substructure.

260. Prepare a bibliography on the chemical reduction of organic thiosulfates.

261. Prepare a list of references which describe the reactions of organodiselenides.

262. What is a straightforward method for producing alkylphenylhalides where the alkyl chain is longer than four carbons?

263. Prepare bibliography on the opening of aziridines with selenium and sulfur nucleophiles.

264. What columns have been developed for the gas chromatographic analysis of a specific material?

265. What about a molecule makes it a good material for capturing electrons?

266. Provide an evaluation for all known tests for hypoxia.

267. What synthesis procedures are known for alpha beta triphenyl tartaric acid?

268. How does one resolve d and l mendelic acid?

269. What is the UV spectrum of alpha beta triphenyl tartaric acid?

270. Provide bibliography on automated methods of analysis.

271. What is the effect of ionizing radiation on specific organs of the body?

272. What methods are available for integrating the area under a curve?

273. What institutions have quality control programs in chemistry?

274. What institutions offer a degree in physical biochemistry?

275. What is the magnetic behavior of a specific compound?

276. What procedures are known for synthesizing a specific compound?

277. What are all known methods for the analysis of a specific compound and what is a comparison of the accuracy of these methods?

278. What is the frequency of dislocations in a sodium azide crystal which was grown by a specific method?

279. What are the "g" values of spin waves of Mn^{++} in sodium azide?

280. What theories have been proposed for the decomposition of alkali azides?

281. What is the identity of corrosion inhibitors used in fuel systems and what are the sources of these compounds?

282. What materials are useful for dying anodized aluminum: what is the identity of these materials and their stability to UV, IR, and various other kinds of radiations?

283. What materials are used as brighteners in nickel plating baths: what is the identity of these materials, and their stability to UV, IR, and various other radiations?

284. What is the effect of weathering on braised aluminum?

285. What laboratory techniques are suitable for the evaluation of fungicides?

286. What are the identity, sources, and properties of titanium organo compounds?

287. What are the identity, sources and properties of aluminum organo compounds?

288. What is the chemical effect of textiles on fungicides?

289. What are the applications of lignin or lignin derivatives?

290. What is the monomeric structure of a specific polymer?

291. Who is the supplier, and what are the physical and chemical characteristics of polymer X?

292. Provide a bibliography on the effects of radiation on polymers.

293. How does a specific polymer stand up to ultraviolet irradiation?

294. What solubility data, hygroscopicity, heat of formation and density are available on a specific compound?

295. In what solvents and to what degree is a specific compound soluble?

296. What are the heats of formation of all compounds with a given empiric formula?

297. What is the reactivity of high energy boron-nitrogen compounds with water vapor?

298. What is the state of the art on the welding of aluminum, magnesium, zinc, and copper alloys?

299. What are the properties of tungsten powder metallurgy compacts?

300. What are the low temperature properties of tin bronzes?

301. What is the compatability of various elastomers with petroleums or specific classes of synthetics?

302. What is the compatibility between certain classes of lubricants and highly oxidizing missile fuels?

303. What synthetic silicones are available with low viscosity and low volatility?

304. What information exists on phospho-sulfur-chromium containing compounds which would be useful as extreme pressure additives?

305. What is the highest temperature to which diesters can be subjected and still have oxidation stability?

306. List all citations on larger-than-band-gap voltages.

307. What methods are known for the control of thickness and composition in evaporated metal alloy films?

308. List all citations on negative ion sources and gas phase generators.